

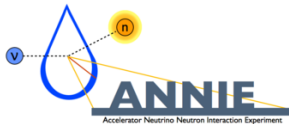
ANNIE experiment - Update and status

AEM - July 11th, 2016

Vincent Fischer

University of California, Davis

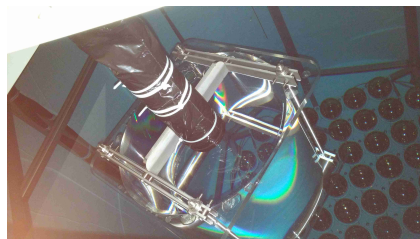
July 11th, 2016



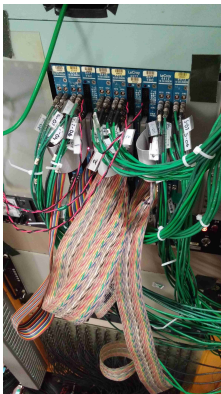
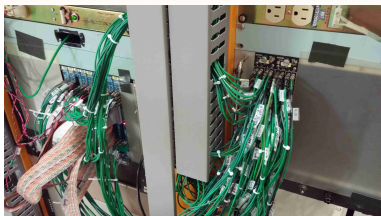
UC DAVIS
UNIVERSITY OF CALIFORNIA

New PMT installation

- Small PMT installed on top of the NCV
- Acts as a trigger to tag energy depositions in the NCV
- Encased in a watertight acrylic tube made at UC Davis
- Replaces one of the two dead channels
- Very low noise and large efficiency
- Will strongly reduce cosmic background



MRD and veto DAQ




- So far, we only had triggers from the veto and MRD layers (through chained discriminators)
- Goal: Retrieve hit information per channel (PMT paddle)
- TDCs connected to the discriminators to retrieve the time information of a hit
- Required amplification of veto and MRD layer 3 signals
- Beam trigger information sent from the trigger board to the CAMAC TDCs

Neutrino 2016


- A lot of ANNIE collaborators were present at Neutrino 2016
- 2 very well-received posters:
 - Carrie McGivern (Iowa State)
 - Marcus O'Flaherty (Sheffield, UK)
- ANNIE has been mentioned several times

Neutrino 2016



The ANNIE Experiment

Carrie McGivern
Iowa State University, for the ANNIE Collaboration



Accelerator Neutrino-Neutron Interaction Experiment

ANNIE is a water Cherenkov neutrino experiment in Fermilab's Booster Neutrino Beamline.

GOAL: to measure the abundance of final state neutrons from neutrino-neutron interactions.

Physics topics: neutrino-neutron interactions, neutrino oscillations, neutrino cross-sections.

v-Nuclei Interactions?

To learn more about neutrino-neutron interactions, we need to understand the complex multi-nucleon system.

Physics topics: neutrino-neutron interactions, neutrino oscillations, neutrino cross-sections.

ANNIE Run 1

Run 1 of ANNIE is currently taking data. It is currently taking data to demonstrate LAPPDs.

Run 1 is currently taking data. It is currently taking data to demonstrate LAPPDs.

Run II Detector System

Run II of ANNIE is currently taking data. It is currently taking data to demonstrate LAPPDs.

Run II is currently taking data. It is currently taking data to demonstrate LAPPDs.

Physics Impact

Neutrino Energy Reconstruction

Energy reconstruction will be essential for GOALS, Figure 4, 7, 8, and 10.

Proton Decay

Proton decay is a major background for neutrino oscillation experiments.

Supernova Neutrinos

Supernova neutrinos are a major source of information about the interior of stars.

Cross Sections in Water

Cross sections in water are a major source of information about the interior of stars.

LAPPDs

Large Area Picosecond Photodetector

LAPPDs (Large Area Picosecond Photodetectors) are a major source of information about the interior of stars.

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Neutrino 2016

RUN I GOALS AND STATUS

By Marcus O'Flaherty & Matthew Malk
The University of Sheffield



ACCELERATOR
NEUTRINO
INTERACTION
EXPERIMENT

PHYSICS MOTIVATIONS

Neutrinos suggest invisible final state neutrinos exist. This could be a **powerful statistical discriminator for underlying interactions if neutrino yield distributions are known**. ANNI and characterise these yields with a well understood neutrino beam (the Fermilab Neutrino Beam).

Applications of neutrino tagging include:

- Identifying π^0 decays in neutrino beams
- Identifying π^0 decays in background to proton deep experiments
- Distinguishing π^0 decays and π^0 decays in π^0 decays
- Improving understanding of neutrino neutrino interactions. ANNI data for π^0 final states will complement other experimental data on π^0 final states.

ANNI will also measure differential cross sections of neutrino-neutrino collisions, including asymmetries in NC/CC comparisons involving carbon/beam targets such as T2C.

SIMULATION

- ANNI has been simulated using Geant4 + Geant4
- Geant4 can be used to model away 100 beam protons
- 10 events per beam 1 primary neutrino
- 100 events per beam 100 neutrinos (1000)
- 1000 events per beam 1000 neutrinos (10000)



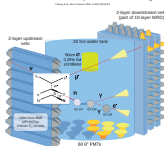
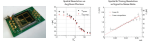
RESULTS AND PROGRESS

- Observations in data (analysis is ongoing)
- Currents are being generated by high intensity, directional illumination
- Beam events: beam energy, uniform light yield
- Current events: beam energy, uniform light yield



PHASE I GOALS

- Characterise backgrounds and detector response, rates of upstream interactions, isolated neutrinos (1000) and neutrinos
- Measure neutrino background with a 100 mrad volume of 100 mrad neutrinos
- Demonstrate beam/CC, performance to the ANNI to be used in physics run
- 1000 events per beam 1000 neutrinos (10000)
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- 1000 events per beam 1000 neutrinos (10000)



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TIMELINE AND FUTURE PROGRAMME

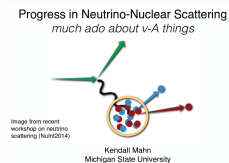
2016	2017	2018
Mar: Task 10, commissioning, first light	Jan: 1000 MCP installation and testing	Oct: 2nd physics run, full LAFD coverage
Apr: First cosmic ray observation, LQD run	Phase II	
May: NCV installation, Phase II build complete	1st physics run with uniform PMT coverage and partial LAFD coverage	
May-Jul: Beam data taking		
Oct-Dec: Additional NCV position data taking		

The ANNIE Collaboration

United States of America	United Kingdom
<ul style="list-style-type: none"> Argonne National Laboratory Brockton National Laboratory Fermilab National Laboratory 	<ul style="list-style-type: none"> University of California at Berkeley University of California at Davis University of California at Irvine University of Chicago Ohio State University



Neutrino 2016



Kendall Mahn



Sara Bolognesi



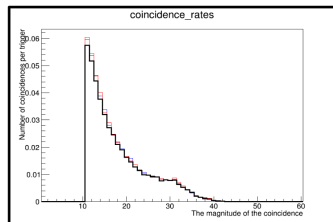
Laura Fields

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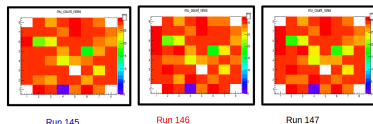
Data analysis

- Several students at Fermilab for the summer working on data analysis
- Automated diagnosis plots generated for each run
- Changes made in the data files processing to allow more efficient analysis

Coincidence Rate



Muon Count Rates



What's next ?

- Continue taking beam data until the BNB shutdown
- Data taking will continue after the shutdown (cosmics, LED calibration)
- More manpower working on analysis
- Discussions are ongoing to better plan ANNIE Phase 1b

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Thank you for your attention !